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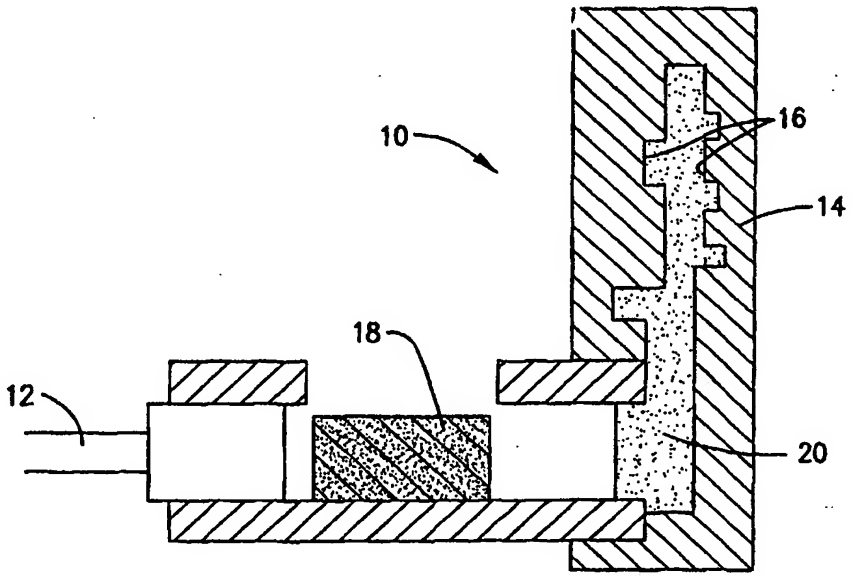
(54) Title: ALLOY FOR SEMI-SOLID CASTING PROCESS



(57) Abstract

A semi-solid casting process uses 390 aluminum alloy as the preferred casting alloy (18) for producing castings (20) with high wear resistance.

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ALLOY FOR SEMI-SOLID CASTING PROCESS

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to the field of metal casting. In particular, the invention is concerned with a semi-solid casting process using an aluminum alloy.

2. DESCRIPTION OF THE PRIOR ART

The use of aluminum in the automotive industry, has become more important with the increased need for weight reduction. Aluminum, however, is soft and various aluminum alloys with better wear resistance characteristics have been developed for use as a casting material.

One of these alloys is 390 aluminum alloy which has been used for automotive components requiring high wear resistance. As those skilled in the art are aware, the use of 390 aluminum alloy, however, presents handling problems. For example, to achieve the desired microstructure for high wear resistance, this alloy Is normally cast in molten form with a reagent added to

prevent clustering of the primary silicon particles. The nature of the semi-solid process is such that addition of reagents is not necessary, as the casting material is semi-solid and not molten.

SUMMARY OF THE INVENTION

The present invention solves the prior art problems discussed above and provides a distinct advance in the state of the art. In particular, the casting process hereof enables the use of 390 aluminum alloy in the semi-solid casting process.

The preferred method in accordance with the present invention includes the steps of producing a slug of aluminum alloy from an MHD or grain refined billet, heating the slug to a predetermined semi-solid temperature and maintain the temperature for a predetermined time, injecting the slug into a mold cavity to form a casting therein, and then removing the casting from the cavity. In the preferred embodiment these steps are performed without adding a reagent to the slug and the preferred alloy is 390 aluminum alloy. Other preferred aspects of this present invention are described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is the sole drawing figure and is a schematic illustration of the preferred semi-solid casting apparatus using a slug of 390 aluminum alloy for implementing the preferred method in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 schematically illustrates conventional semi-solid casting apparatus 10 for implementing the preferred method in accordance with the present invention. Apparatus 10 includes hydraulic cylinder or ram 12 and mold 14 defining mold cavity 16 therein. In operation, ram 12 injects semi-solid slug 18 into cavity 16 to form casting 20 therein. Casting 20 is then removed from mold 14 and cooled.

In the preferred embodiment, slug 18 is composed of 390 aluminum alloy or the equivalent thereof. Specifically, 390 aluminum alloy includes:

silicon between about 16.0 and 18.0%(by weight),
iron less than about 0.40 %,
copper between about 4.0 and 5.0%,
manganese less than about 0.10%,
magnesium between about 0.50 and 0.65%,
nickel less than about 0.10%,
zinc less than about 0.05%,
titanium less than about 0.20%,
lead and tin less than about 0.03%,
with the remainder of alloy being aluminum.

Slug 18 is produced by cutting from an MHD or grain refined billet. Such a billet presents the desired microstructure to produce casting 20. Other methods may also be used to produce slug 18, but this is the most common method in use today. The volume of slug 18 is predetermined and substantially equal to the volume of finished casting 20.

After cutting slug 18 from the billet, slug 18 is heated to about 567°C (predetermined semi-solid temperature) using heating equipment for semi-solid casting. At the semi-solid temperature, slug 18 is solid enough to retain its shape but is sufficiently soft to flow into cavity 16 and take the shape thereof in order to form casting 20 during the semi-solid casting process.

In the prior art, it has been required to add a reagent to 390 aluminum alloy along with other chemical agents before casting while the material is in the molten state in order to achieve the desired microstructure of the finished casting. In the semi-solid process, a reagent or other chemicals cannot be added to slug 18 because of its semi-solid state.

Contrary to the prior art, however, it has been discovered by the inventor hereof that a slug 18 of 390 aluminum alloy can be heated to the semi-solid temperature without significantly losing the desired microstructure as presented in the billet from which the slug was cut. Moreover, it has been discovered that the slug 18, at the semi-solid temperature, can be injected into mold cavity 16 of semi-solid casting apparatus 10 without significantly losing

the desired microstructure in the resulting casting 20. Using the preferred method hereof, casting 20 presents a tensile strength between about 51 and 57 ksi and an elongation of less than about 1% after the casting undergoes preferred heat treatment procedure T6 consisting of solution treatment at 496°C for eight hours, water quenched, and then artificially aged at 176°C for five hours followed by conventional cooling. Finally, it has been discovered that the semi-solid process can be used without abnormal wear on mold 14.

Those skilled in the art will now appreciate that the present invention enables the production of wear resistant, aluminum alloy castings using the semi-solid casting process with all of the attendant benefits of the semi-solid casting process. It will also be appreciated that the present invention encompasses many variations in the preferred embodiment described herein. For example, some deviation can occur in the specified ranges for the chemical components of the preferred 390 aluminum alloy without substantially defecting the quality of the resulting casting. Also, other heat treatment procedures can be used. Having thus described the preferred embodiment, the following is claimed as new and desired to be secured by Letters Patent:

CLAIMS:

1. In a semi-solid casting process in which a slug of an alloy is heated to a semi-solid temperature and injected into a mold cavity to form a casting therein, the improvement comprising:

injecting an aluminum alloy as said alloy, said aluminum alloy including

silicon between about 16.0 and 18.0%,
iron less than about 0.40 %,
copper between about 4.0 and 5.0%,
manganese less than about 0.10%,
magnesium between about 0.50 and 0.65%,
nickel less than about 0.10%,
zinc less than about 0.05%,
titanium less than about 0.20%,
lead and tin less than about 0.03%,
with the remainder of said alloy being aluminum.

2. The improvement as set forth in claim 1, said aluminum alloy including 390 aluminum alloy.

3. A method of making a casting comprising:

(a) producing a slug of selected size from a billet of an aluminum alloy having a desired microstructure;

(b) heating said slug to a predetermined semi-solid temperature and maintaining said temperature for a predetermined time;

(c) in a semi-solid casting process, injecting said slug into a mold cavity to form a casting therein; and

(d) removing said casting from said cavity and allowing said casting to cool,

said method further including the step of performing steps (a) - (c) without adding a reagent to said slug,

said aluminum alloy including

silicon between about 16.0 and 18.0%,
iron less than about 0.40 %,
copper between about 4.0 and 5.0%,
manganese less than about 0.10%,
magnesium between about 0.50 and 0.65%,
nickel less than about 0.10%,
zinc less than about 0.05%,
titanium less than about 0.20%,
lead and tin less than about 0.03%,
with the remainder of said alloy being aluminum.

4. The method of claim 3, step (b) including the step of heating said slug to a temperature between about 565°C and 580°C.

5. The method of claim 3, step (b) including step of maintaining said semi-solid temperature for between about 10 and 20 minutes.

6. The method of claim 3, said method including the step of making one of a steering component, crank shaft hub, compressor piston, swash plate, and transmission oil housing as said casting.

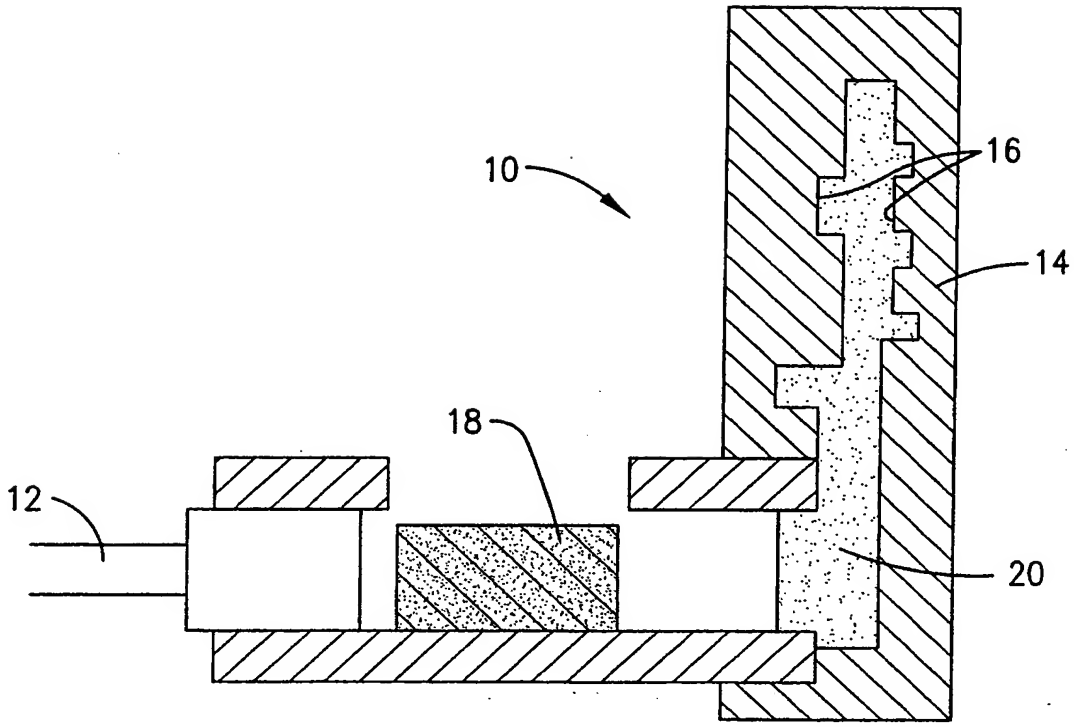

Fig. 1.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/30322

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B22D 17/10, 25/00
US CL :164/113

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 164/76.1, 113, 476, 900; 148/549

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WEST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,846,350 A (BERGSMA) 08 December 1998, col. 6, lines 34-67; col. 9, lines 56-62; col. 10, lines 43-54; col. 12, lines 42-49 and col. 12, line 66 through col. 13, line 3.	1-6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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